

EFFECT OF CHANGING THE WATER COMPOSITION IN THE ELECTROLYTE ON THE MORPHOLOGY OF TiO₂ NANOTUBE

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<https://doi.org/10.5281/zenodo.15672677>

The effect of varying H₂O and F⁻ concentration in electrolytes on TiO₂ morphology has been extensively studied. The effect of fluoride content during anodization has little effect on nanotube diameter and oxide layer growth [1], but leads to tube length, its growth rate, and higher order [2-3]. In contrast the amount of water in the anodizing cell significantly increases the pore diameter, but reduces the oxide expansion coefficient, pore length, growth rate and efficiency. Electrochemical impedance spectroscopy (EIS) was used to monitor the growth of the barrier layer formed during the anodization of TiO₂ in an electrolyte containing F⁻ ions, which also allowed us to study the effects of the concentration of F⁻ ions in the solution and the pH medium of the electrolyte. [4-5].

Research results

The formation of TiO₂ nanotubes depends on various factors, one of which is the chemical aggressiveness of the medium, since the formation of nanotubes from nanoporosity requires the dissolution of Ti oxofluorides formed between the tube walls.

During the anodizing process, when a voltage of 0 to -0.8V is applied, an increasing H₂O content in the electrolyte from 1.0 to 5.0 % leads to a significant increase in the aggressiveness of the medium, while significantly reducing the time spent on dissolving the oxide layer on the electrode surface. The scan rate was set to a constant value of 20 mV/s, and the half-wave potential E(V)-(-0.7 V) was observed in the electrolyte containing 1% H₂O, starting at 10 seconds and giving an analytical signal of -1.36 V, at 210 seconds, with a 5% H₂O content, E(V)-(-0.82 V) was observed in the electrolyte containing 9.7 seconds and giving an analytical signal of -1.38 V, at 146.38 seconds, with a 10 % H₂O content, E(V)-(-0.63 V) was observed in the electrolyte containing 10 % H₂O, E(V)-(-0.64 V) was observed in the electrolyte containing 25% H₂O, E(V)-(-0.64 V) was observed in the electrolyte containing 9.9 seconds and giving an analytical signal

of -1.36 V, at 147.4 seconds, and It can be seen that in the presence of 50 % H₂O, E(V)-(-0.83 V) starts at 10.21 seconds and gives an analytical signal of -1.48 V at 5.2 seconds. Considering the above results, it was shown that in the electrolyte containing 0.20M NH₄F, when 5% H₂O was present, the formed nanotubes were highly ordered and had flat surfaces. When 1% H₂O was present, the nanotubes were not highly ordered and not fully formed, and when 10% H₂O was present, the nanotubes were not fully formed. In the presence of H₂O, nanotubes with a non-highly ordered structure are formed, in the presence of 25% H₂O nanotubes with a non-uniform diameter are formed, and in the presence of 50% H₂O nanotubes with a non-highly ordered structure are formed with a large diameter (Fig. 1a).

Initially, the main reason for the increase in current with increasing concentration is that there are enough charge carriers in the solution, and the charges move more, which leads to an increasing in the analytical signal. After a certain amount, the excess charge carriers increase and, as a result, the density of the charge movement paths slows down the diffusion. As a result, the analytical signals become smaller. Important factors affecting on electrical conductivity are the mobility of ions or electrons and the internal structure of the materials.

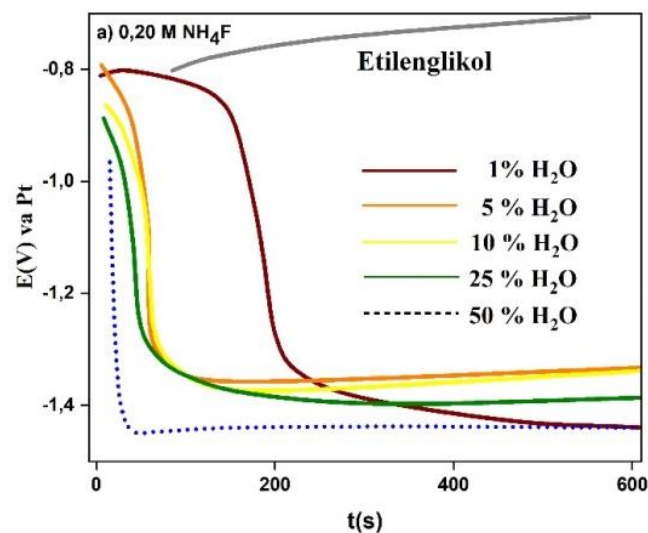


Figure 1. Time-dependent half-wave potential of electrolytes consisting of a) 0.2M NH₄F (1, 5, 10, 25, 50%) H₂O and ethylene glycol, b) 1% H₂O (0.05, 0.10, 0.20, 0.35, 0.50 M) NH₄F and ethylene glycol

Referanses:

1. Zwilling, V., Darque-Ceretti, E., Boutry-Forveille, A., David, D., Perrin, M. Y., & Aucouturier, M. (1999). Structure and physicochemistry of anodic oxide films on titanium and TA6V alloy. *Surf. Inter. Anal.*, 27(7), 629-637.

2. Gong, D., Grimes, C. A., Varghese, O. K., Hu, W., Singh, R. S., Chen, Z., & Dickey, E.C. Titanium oxide nanotube arrays prepared by anodic oxidation. *Journal of Materials Research*, (2001). 16, 3331-3334.
3. Mahajan, V. K., Misra, M., Raja, K. S., & Mohapatra, S. K. Self-organized TiO₂ nanotubular arrays for photoelectrochemical hydrogen generation: effect of crystallization and defect structures. *Journal of Physics D: Applied Physics*, (2008). 41(12), 125307.
4. Wu, W., & Zhang, Z. (2017). Defect-engineered TiO₂ nanotube photonic crystals for the fabrication of near-infrared photoelectrochemical sensor. *Journal of Materials Chemistry B*, 5(25), 4883-4889.
5. Zhang, K., Cao, S., Li, C., Qi, J., Jiang, L., Zhang, J., & Zhu, X. Rapid growth of TiO₂ nanotubes under the compact oxide layer: Evidence against the digging manner of dissolution reaction. *Electrochem. Comm*, (2019). 103, 88-93.